In Situ Permeability Measurements with Direct Push Techniques

Technology Need:

A need exists within the Department of Energy (DOE) for characterization tools that combine the ability to measure local soil properties (e.g., permeability, conductivity) and hydrogeologic features with the capability of being adaptable to cone penetrometer and other direct push emplacement technologies. This general need can be further defined as follows: (1) knowledge of soil gas permeability is needed to design soil vapor extraction systems and to understand the general movement of gas in soil; (2) knowledge of saturated hydraulic conductivity, or the soil's permeability to liquid flow, is required to predict the movement of groundwater in saturated soils; and (3) measurement systems for penetrometers are needed, in general, because they provide vastly more data in the same amount of time as do drilled holes, at much lower cost and risk to the users.

Technology Description:

Direct push techniques, such as cone penetrometer (CPT) and sonic hole formation technologies, have been applied to rapid characterization of soil properties and contaminant distribution in soils. Permeability measurements using conventional models, however, are difficult or impossible to conduct with these techniques because of the potentially significant reduction in soil permeability adjacent to the emplacement rod. However, it is possible to avoid the impact of localized soil compaction caused by penetrometer emplacement through judicious selection of the measurement geometry.

Science and Engineering Associates (SEA) has developed the Cone Permeameter™, a probe for in situ depth-discrete estimation of permeability in the vadose and saturated zones with high spatial resolution. The probe is deployed using a cone penetrometer truck. The Cone Permeameter™ field measuring system is based on the pressure response of the subsurface to injection of water or air into the subsurface. The flow rate and resulting pressure profiles are collected and the system calculates the permeability for real-time display.

The technique used in this project is a spherical, one dimensional steady state porous flow model which is suitable for both soil gas and water (saturated) permeability measurements. A particularly unique feature of the system is that it can be applied in a manner to minimize the effects of soil compaction near the penetrometer surface, and effectively measure the native

Cone Permeameter™ System

soil permeability.

Benefits:

Conducting permeability measurements with direct push techniques, instead of in drilled boreholes, retains all of the advantages of penetrometer emplacements which have motivated the DOE to advance the direct push capabilities. Benefits of this technology include:

<Complements standard CPT soil properties measurements

<Substantially reduced field costs

<Rapid emplacement

<Minimal secondary waste generation

<Reduced worker exposure to chemical and radiological hazards

The cost savings of the proposed approach, when compared to drilled borehole measurements, are significant. Borehole formation costs range from tens to hundreds of thousands of dollars for a typical well, depending on the type of drilling operation, nature of contamination, depth of well, and the geologic media.
A typical drilling operation for a 100 ft well requires two to five days. By contrast, penetrometer emplacements can be accomplished in one day with a full suite of measurements. For gas permeability, the measurement time per station is less than five minutes, so 20 to 40 measurements could be accomplished during one push, in one day. This provides a great deal of spacial resolution in permeability measurements.

Status and Accomplishments:

This project was completed in March 1999. The Cone Permeameter™ technology has been demonstrated and deployed several times at the Savannah River Site (SRS). It was demonstrated during May 1998 at a DNAPL site in the M-Area, demonstrated/deployed at the Old Radioactive Waste Burial Ground in June 1998, and deployed in June 1998 at the D-Area Coal Pile Runoff Basin.

SEA demonstrated the Cone Permeameter™ at Hanford in the 200 East Area in November 1998. This demonstration was not funded through this contract, but resulted from the request of a Hanford attendee at the SRS Visitor's Day in April, 1998.

The Cone Permeameter™ was deployed (non-DOE) at Kennedy Space Center, Cape Canaveral Air Station in December 1998 through January 1999. This was part of DOE's cooperation with EPA and Interagency DNAPL Consortium for characterization and remediation of contamination at the site.

On August 8, 2000 patent no. 6,098,448 was granted for this technology.

Contacts:

William (Bill) E. Lowry
Science & Engineering Associates, Inc.
Phone: (505) 424-6955
E-mail: blowry@seabase.com

Karen L. Cohen
National Energy Technology Laboratory
Phone: (412) 386-6667
E-mail: karen.cohen@netl.doe.gov

Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 307
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov

For more information on this and other technologies, please visit SEA's website at http://www.seabase.com